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Anglian Water Reservoirs Programme

This is one of 15 case studies informing the Infrastructure Systems Review.

System: Fens Reservoir and regional water resources.

Systems contribution and value: Introduced a requirements hierarchy, common database, ownership and change control as a basis for scope and programme decisions. Improved requirements clarity and traceability, with potential to reduce scope creep, rework and investment risk.

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Summary

Anglian Water (AW) is developing two nationally significant water supply reservoirs in the east of England to strengthen water resilience in response to climate change, population growth, and increasing environmental pressures. This case study examines how the Reservoirs Programme is applying requirements engineering and management (RE&M) to embed systems thinking and optimise outcomes for people, places, the environment, and water resources.

The programme spans multiple interconnected systems, including communities, land use, agriculture, water networks, and infrastructure. It supports key UK priorities such as economic growth, net zero, climate adaptation, and environmental enhancement. A systems thinking approach recognises that successful outcomes depend on understanding and managing the relationships between these elements to create benefits greater than those achieved by components in isolation. To support this, RE&M has been adopted from the earliest stages of project development to define desired outcomes, analyse needs and constraints, and maintain alignment between stakeholders, project objectives, and delivery solutions.

By providing a structured, traceable framework for connecting needs, outcomes, and interventions, RE&M helps ensure that proposed solutions are viable, feasible, and capable of delivering intended benefits. This approach increases confidence in achieving project objectives while supporting better value and more effective investment decisions given a full understanding of their consequences.

From the early stages of the project, RE&M has established a strong foundation for achieving the seven key success factors associated with systems thinking.

Major infrastructure programmes often underperform because objectives, needs and requirements become disconnected over time. This case study demonstrates how RE&M can provide a scalable and practical mechanism for improving infrastructure productivity, reducing delivery risk, and increasing confidence in achieving desired outcomes.

Scope

The AW reservoir programme will deliver two nationally significant, once-in-a-generation water resource projects in East Anglia. It includes the infrastructure needed to abstract, store, treat, and transfer water across the AW and Cambridge Water regions, supplying up to 253 million litres per day to 750,000 homes. This study focuses on the Fens Reservoir, though the approach also applies to its sister, the Lincolnshire reservoir. Together, the projects will improve resilience to climate change, population growth, and environmental pressures.

In the early concept stage, AW adopted a systems-thinking approach, working closely with stakeholders and regulators to define clear outcomes. These aim to deliver benefits beyond water supply and are shaped by corporate policy and regulatory requirements. Engagements identified important strategic interactions, including:

- Establishment of a strategic partnership, Future Fens Integrated Adaptation. It brings together stakeholders involved in managing water across the landscape and across sectors, to determine the actions they can jointly take to secure a vibrant future for the Fens.
- Engagement with the Department for Environment, Food and Rural Affairs' (Defra) Water Delivery Task Force and regulators, to chart the path between environmental compliance and supporting growth.
- Engagement with the Regulators' Alliance for Progressing Infrastructure Development (RAPID) to promote the development of national water resources infrastructure that is in the best interests of water users and the environment. This has yielded a transparent, gated governance process.

The evidence base for systems change Anglian Water Reservoirs Programme

These engagements have helped define the desired project objectives and outcomes, and limit conflicting regulatory interpretations.

This case study examines the use of RE&M to ensure project outcomes are delivered through effective interventions. RE&M helps manage constraints, existing and new systems, key interfaces, and stakeholder requirements. The programme has established a structured, traceable hierarchy that clearly defines and cascades objectives to drive successful project interventions, illustrated in Figure 1.

The hierarchy provides a clear line of sight from corporate objectives to the interventions delivered. As a result, all programme activities can be linked directly to an objective, ensuring investment is justified and value-driven.

By working top-down – defining desired outcomes, identifying systems, then determining necessary interventions – the project focuses on delivering only what is required.

RE&M is widely used in sectors such as rail and aviation but is not yet common practice in the water industry. To improve efficiency and productivity through cross-sector learning, the AW Reservoirs Programme is applying RE&M to define and manage the diverse stakeholder needs, aspirations, and physical constraints associated with the project.

The study focuses on the use of RE&M during the early project phases to define outcomes, systems and interventions, enabling robust, defensible and mutually beneficial solutions. It does not explore the details of regional and regulatory engagement activities and, given the current stage of the programme, cannot yet quantify the actual achievement of outcomes.

Several studies have demonstrated that RE&M results in better cost and schedule performance, improving certainty of delivery in a sector where confidence in delivering outcomes within budgetary and programme constraints needs improving.[1]

Outcomes

Given the stage of the Reservoir Programme development, actual outcomes are as yet unknown. However, to understand the desired outcomes it is essential to conduct a robust needs and benefits assessment to define the project objectives. The fundamental need for the Fens reservoir was defined in the AW Water Resources Management Plan, 2024, the need for which is driven by population growth, climate change and environmental constraints, detailed in Figure 2.

In addition, corporate and regulatory demands require improved outcomes for people, nature and place, all to be delivered within customer affordability limitations.

Implementing RE&M directly assisted with the clarification and definition of these complex interfaces, creating a hierarchy (Figure 1) that will provide a clear line of sight to the desired outcomes and provide assurance for the sponsor, developer, regulators and investors.

This hierarchy was created by remapping and 'systemising' the programme objectives document, previously created by the programme sponsor. This exercise created a hierarchy of objectives, benefits and requirements. The project sponsor used the hierarchy to define project benefits, set specific requirements and determine necessary interventions.

1 Systems engineering for intelligent transportation systems: Section 2.6, cost and schedule impacts of systems engineering. US Department of Transportation, Federal Highway Administration. ops.fhwa.dot.gov

Figure 1. Requirements hierarchy

Owner	Requirements level	Examples
Government and regulators (Defra, OFWAT, EA, NE, DWI, etc.)	**Level 0: Statutory duties**	Government and regulators
Anglian Water (Reservoirs Programme Board)	**Level 1: Corporate objectives and commitments**	Business purpose; strategic direction statement; WRMP; PR24; ACWG design principles
Sponsor	**Level 2: Needs and benefits**	Deployable output; operational constraints; sustainability targets
Programme/Project teams	**Level 3: Functional, performance and commitments**	System definition & scope; DCO and other site-specific commitments

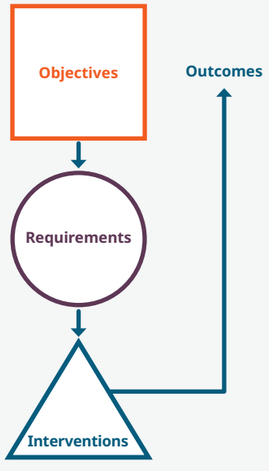
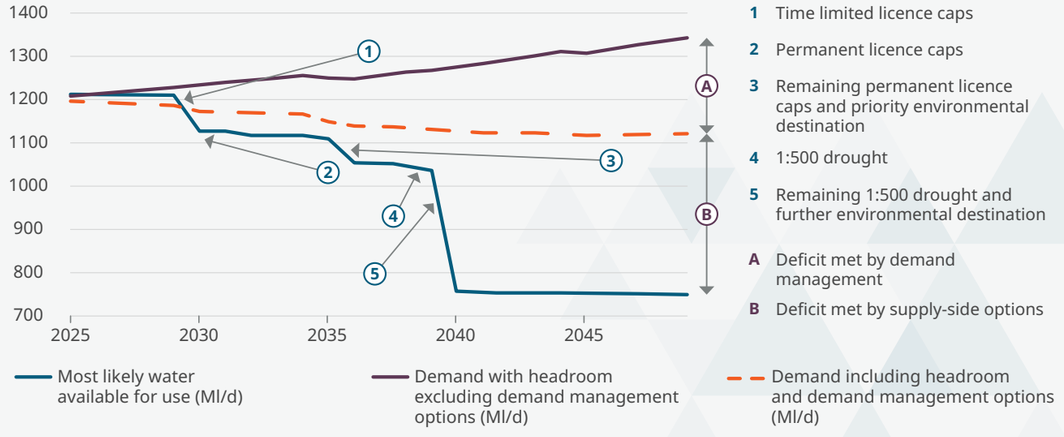


Figure 2. Regional water supply challenges



Level 1 objectives are shown opposite.

Although generic in nature, the objectives clearly state national missions and aspirations around growth, net zero, resilience and productivity that can be cascaded from executive level to all levels involved in defining and delivering required interventions. They support the definition of detail and analysis of trade-offs between potentially competing objectives such as carbon reduction, the creation of economic value and customer affordability. They also focus attention on creating alignment between interventions to maximise the intended overall benefit.

Setting objectives in this way has

- created a database of objectives and benefits to enable the development of requirements that can be tested, adopted and changed in a transparent and clearly governed environment.
- enabled clear levels of accountability and delivery responsibility.
- provided consistent 'guardrails' within which the team can operate and make decisions, while understanding where potential deviations from defined requirements should be escalated and/or follow systematic change control.
- embedded a systems approach.

The last point is demonstrated by assessing project performance against the seven 'success factors' used to appraise all of the Infrastructure Systems Review case studies. They are represented in Table 2, over page.

Systems

The Fens Reservoir system outlined in Figure 4 will operate within a number of wider systems including physical/geographical, organisational, commercial, environmental, social, regulatory and many others. The physical system of the Fens Reservoir spans approximately 50km north to south, from a river abstraction on the River Nene near Peterborough to supply points near Cambridge (Cambridge Water) in the south, and near Chatteris (AW) in the east. Interfaces are with the ground (geology and groundwater) and surface water systems. There are also multiple infrastructure system interfaces including homes, businesses, highways, railways and utilities.

The resulting interventions (comprising the project) will be developed, delivered and operated within a complex regulatory environment that needs to be clearly understood and defined. This will significantly influence the technical solutions that drive water supply, social and environmental outcomes.

The project will be delivered via a specified infrastructure project regulations[2] (SIPR) commercial model that includes developers (water companies), investors, infrastructure provider and main works contractors. Commercial arrangements will need to ensure appropriate reward for each organisation whilst providing the customer, via the regulators (Ofwat[3] and RAPID[4]) value for money: the project needs to be both investible and affordable.

Collating the intervention/project requirements in a single database provides consistency, visibility and transparency across the entire project team. This minimises silos, ensures that solutions are focused on common constraints that can be both competing and complementary, and provides visibility of the many potential trade-offs. The early requirements capture has focussed on the needs of these physical, regulatory and commercial stakeholders.

Understanding and bringing the systems together through requirements will ultimately define the nature, design and delivery of the interventions. Interventions will be components of the 'system-of-systems' delivering the desired outcomes within defined budgetary and programmatic constraints.

The RE&M process enables a systematic process for identifying the 'systems of interest' to the programme – those that the interventions will need to modify to achieve objectives and outcomes. It also enables the subsequent management and assurance to support delivery of the interventions.

Interventions

Having established the programme objectives and system definitions, the project team has a strong foundation for identifying and defining the interventions required to deliver the desired outcomes. This structured hierarchy enables robust scope control and provides confidence that all necessary interventions are captured.

Given the scale and multidisciplinary nature of the team, a consistent approach to requirements development is essential. The RE&M process decentralises requirements capture, allowing all team members to draft and submit requirements directly into the requirements management tool. Requirements are generated through internal activities, including surveys, planning and design, as well as external engagement with regulators, stakeholders and the public. The RE&M process provides a systematic framework for identifying, managing and assuring requirements throughout programme delivery.

Level 1 and Level 2 requirements have been derived from legislation, corporate business plans and the Water Resources Management Plan 2024. They have been approved through corporate governance processes. Level 3 requirements are developed through a controlled process of identification, capture, review, adoption and change management.

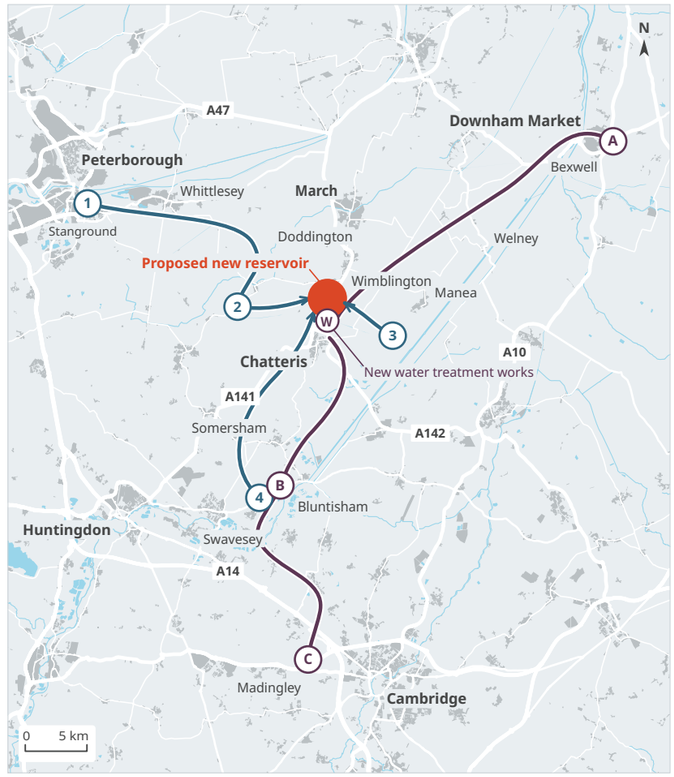
The requirements baseline will be maintained through delivery and handover, with validation and verification

2 Specified Infrastructure Project Regulations (SIPR) is a commercial arrangement being widely adopted across the water industry that enables an infrastructure provider to finance and develop an asset, and to own the asset (through a license) for the duration of a defined license period.
3 Ofwat is the economic regulator of the water sector.
4 Regulators' Alliance for Progressing Infrastructure Development (RAPID) – has been established to accelerate the development of new water infrastructure and design future regulatory frameworks. The joint team is made up of the three water regulators Ofwat, Environment Agency and Drinking Water Inspectorate.

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Anglian Water Reservoirs Programme

Fens Reservoir system

Anticipated physical extent



Water to reservoir

1. Water from the River Nene and its Counter Drain transferred to the reservoir via the Middle Level system
2. Water from the River Nene and the Middle Level system transferred to the reservoir
3. Water from the Ouse Washes (River Delph) transferred to the reservoir
4. Water from the River Great Ouse transferred to the reservoir

Treated water into supply

- **A** Treated water transferred to Anglian Water supply at Bexwell
- **B** Treated water transferred to Cambridge Water supply at Bluntisham
- **C** Treated water transferred to Cambridge Water supply at Madingley

Key

- Water to reservoir
- Treated water into supply

Level 1 objectives

FR-01 Performance
Provide and maintain sufficient water supply

FR-02 Compliance
Comply with applicable legislation and standards

FR-03 Affordability
Maintain customer affordability

FR-04 Safety & Security
Maintain and promote safety, health, wellbeing and security

FR-05 Operational Resilience
Provide a resilient water supply system

FR-06 Carbon and Climate
Deliver a climate resilient and carbon-efficient project

FR-07 Environment
Maintain and enhance the environment

FR-08 Social Value
Create positive social and economic Value

providing assurance of compliance and demonstrating achievement of programme objectives and outcomes.

The interventions are expected to include:

- a non-impounding water supply reservoir
- operational changes to adjacent water systems
- modification of existing infrastructure
- recreational facilities
- creation of environmental habitats
- employment and educational opportunities for local communities.

These interventions will be developed in parallel, with clear traceability showing how each contributes to programme outcomes and objectives within an integrated system.

Economic assessment

The reservoirs programme operates at the interface of natural water sources, existing distribution networks, and a broad range of physical, regulatory, commercial, environmental and social systems. These interconnected systems create multiple interfaces, competing objectives and constraints that must be managed simultaneously.

A key economic challenge is that the benefits of effective RE&M are distributed across the programme, while the effort to define and maintain requirements is incurred early in development. RE&M addresses this information gap by providing a structured process that maintains a clear line of sight between objectives, benefits, requirements and interventions, improving decision-making and maximising programme-wide value.

The principal intervention has been the adoption of RE&M from the earliest stages of programme development. This has established a traceable hierarchy linking corporate objectives, programme benefits, requirements and delivery interventions. Consequently, all programme activities can be directly linked to strategic objectives, improving investment justification, governance and accountability.

Although the programme is still at an early stage and long-term outcomes cannot yet be quantified, several benefits have already been realised:

- Executive objectives were remapped to distinguish statutory requirements, core outcomes and desirable enhancements, improving accountability and reducing the risk of conflicting priorities.
- Formal requirements elicitation established transparent scope and cost baselines, strengthening governance and limiting uncontrolled change.
- Clear requirements and system constraints focused teams on agreed outcomes, enabling earlier escalation of strategic issues and improved risk identification and mitigation.
- SMART requirements created a single source of truth, reducing ambiguity, limiting siloed decision-making and promoting consistent stakeholder understanding.
- The requirements process improved decision quality by helping teams differentiate essential requirements from desirable enhancements.
- Standardised workflows and governance processes established a consistent approach to requirements development, change management and assurance, improving efficiency.
- RE&M provides traceability from regulatory and sponsor objectives to project delivery, supporting assurance that interventions remain aligned with intended outcomes.
- The approach is expected to strengthen confidence among shareholders, regulators and investors by demonstrating continued alignment with agreed strategic objectives.
- Requirements-based acceptance criteria support a common assurance process across stage gates, reducing duplication in verification and validation activities.

Major programmes often struggle when objectives, outcomes, and requirements become disconnected. RE&M provides a scalable, cross-sector framework for maintaining alignment, reducing delivery risk, and improving infrastructure productivity.

Further benefits are expected as the programme progresses. The established hierarchy of objectives, requirements and interventions will underpin validation, verification and delivery assurance, helping maintain alignment throughout development, delivery and operation.

While the programme is not yet mature enough to quantify realised economic outcomes, evidence to date indicates that RE&M has improved governance, transparency, accountability and decision-making. Its principal economic value is expected to arise from reduced delivery risk, avoidance of costly rework and scope changes, better alignment across systems and stakeholders, and increased confidence that strategic outcomes will be delivered efficiently and effectively.

Systemic assessment

Implementing RE&M provides a structured approach to identifying, documenting and managing stakeholder needs, while increasing confidence in achieving successful delivery. Its core purpose is to reduce rework, align teams around clear objectives, manage project risks, and ensure outcomes deliver real value to customers and stakeholders. It does so by:

- Reducing rework and cost, by identifying and resolving unclear or misunderstood requirements early, when changes are significantly less expensive.
- Improving communication through a single source of truth and shared terminology, ensuring alignment between technical teams and non-technical stakeholders.
- Controlling scope creep, by introducing disciplined change management, where proposed changes are assessed for cost, effort, risk and business value before approval.
- Ensuring compliance and business alignment, by linking requirements to regulatory, legal, investor, and organisational objectives.
- Supporting traceability and testing, by tracking requirements from origin through development and verification, ensuring all essential features are delivered and validated.
- Capturing organisational knowledge in a structured, reusable format that remains available despite changes in personnel or suppliers.

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Systemic assessment

The programme has been assessed against seven ‘success factors’ and scored on a four level scale:
0 – Not met | 1 – Partly met | 2 – Mostly met | 3 – Fully met.

Success factor	Assessment	Rationale
1. Outcome clarity	**3**	The programme has a clearly defined hierarchy of objectives > outcomes > requirements. Scope boundaries, governance and traceability are explicit and formally managed.
2. Systems capability	**3**	Requirements engineering is itself a systems discipline. The programme explicitly identifies physical, regulatory, commercial, environmental and social systems and their interactions.
3. Leverage focus	**2**	The intervention focuses on requirements management, which is a genuine leverage point influencing later design and delivery outcomes. The programme needs to further identify how specific leverage points will be identified and prioritised.
4. Authorising leadership	**3**	Corporate governance structures are evident and requirements are formally approved and controlled. Leadership has clearly authorised the approach and embedded it into programme governance.
5. Incentive alignment	**2**	The specified infrastructure projects regulations commercial model recognises the need to balance customer value, investor returns and regulatory objectives. Further development required to ensure that incentives can be systematically aligned around whole-system outcomes.
6. Decision quality	**3**	The entire requirements engineering process is designed to improve decision quality through evidence, traceability, governance and change control. The single source of truth is a major strength.
7. Adaptive learning	**2**	Validation, verification and change management mechanisms exist. There is relatively little evidence yet of learning loops operating over time because the programme remains at an early stage.

Major programmes often struggle when objectives, outcomes, and requirements become disconnected. RE&M provides a scalable, cross-sector framework for maintaining alignment, reducing delivery risk, and improving infrastructure productivity. Better infrastructure outcomes are achieved through the effective definition, integration, and management of outcomes, requirements and interfaces.

Recommendations

Implement RE&M from the earliest project phases. Early adoption enables project objectives to be clearly defined, tested, and agreed before major investment decisions are made. It establishes a baseline for solution development, reducing the tendency to move prematurely into design and thereby minimising rework. It also avoids the need to retrospectively define objectives when conflicts and trade-offs emerge. It promotes a systematic approach that demonstrates how proposed interventions contribute to desired outcomes – an important factor in securing regulator and investor confidence.

Make RE&M a core project discipline. RM should be maintained throughout the project lifecycle, from concept development through construction and handover. This provides a clear justification for each intervention, defines and controls project scope, supports risk management, and demonstrates delivery against agreed objectives. It also promotes consistency and stakeholder engagement, establishes a robust baseline for change control, reduces rework caused by poorly defined requirements, and creates a lasting assurance record.

Measure outcomes effectively. Projects should include an embedded framework to assess whether actual outcomes achieve the intended benefits and objectives, enabling evidence-based evaluation of success.

Secure leadership engagement. Project promoters, sponsors, and senior executives should remain actively engaged in the RE&M process to ensure strategic alignment, informed decision-making, and sustained organisational commitment throughout delivery.

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ice.org.uk